Reducing Greenhouse Gases in the U.S. Transportation Sector

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Overview

- Purpose: Look at Feasibility of Realizing 7% Reduction from 1990 Levels of Carbon Emissions in the Transportation Sector by 2010
- Focus on Light Vehicles
  - » Efficiency
  - » Alternative Fuel
  - » VMT

Carbon Emissions (MMTC)

	1996	Percent
World Carbon	5983	100%
United States	1463	24%
U.S. Transportation (33% of U.S.)	477	8.0%
Light Vehicles (59% of trans.)	*282*	*4.7%*
Heavy Trucks (17% of trans.)	*83*	*1.4%*
Air (9% of trans.)	*42*	*0.7%*
Other (15% of trans.)	*70*	*1.2%*

Source: EIA, Annual Energy Outlook 1999, DOE/EIA-0383(99), December 1998 (detailed model data manipulated by DOE/OTT).

Kyoto Protocol

- December 1997 - Binding targets and timetables for GHG reductions for industrial countries
  - U.S.: 7% below 1990 levels in the 2008-2012 period
- November 1998 - Buenos Aires Action Plan established deadlines for finalizing work on the mechanisms:
  - Joint Implementation
  - Emission Trading
  - Clean Development Mechanism

Carbon Reductions for the U.S. in 2010 (-7% Case) versus the Reference Case for 2010

Sector	Reduction
Total U.S	30.6%
Electricity Generation	56.6%
Commercial	51.2%
Residential	44.5%
Industrial	27.8%
Transportation	16.2%

Source: EIA, Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity, SR/OIAF/98-03, October 1998.

Percent Carbon Reductions within Transportation Sector, 2010 and 2020

	2010	2020
Light Vehicles	19%	18%
Comm. Light Trucks	12%	13%
Freight Trucks	6%	6%
Air	16%	10%
Rail	30%	33%
Marine	3%	1%

Source: EIA, Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity, SR/OIAF/98-03, October 1998.

Potential Carbon Reduction Targets for Light Vehicles (MMTC)

	2010	2020
Trans. Share w/Carbon Tax	66 (19%)	68 (18%)
Pro Rata Share	108 (31%)	132 (35%)
Baseline Carbon Emissions from Light Vehicles	348	377

Source: EIA, Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity, SR/OIAF/98-03, October 1998.

Three Options for Reducing Carbon from Light Vehicles (Impacts Estimated for 1998)

① Increase the fuel economy of the light vehicle fleet

★ A 1 mpg gain in fuel economy for all cars and light trucks would reduce carbon emissions by about 13 MMTC

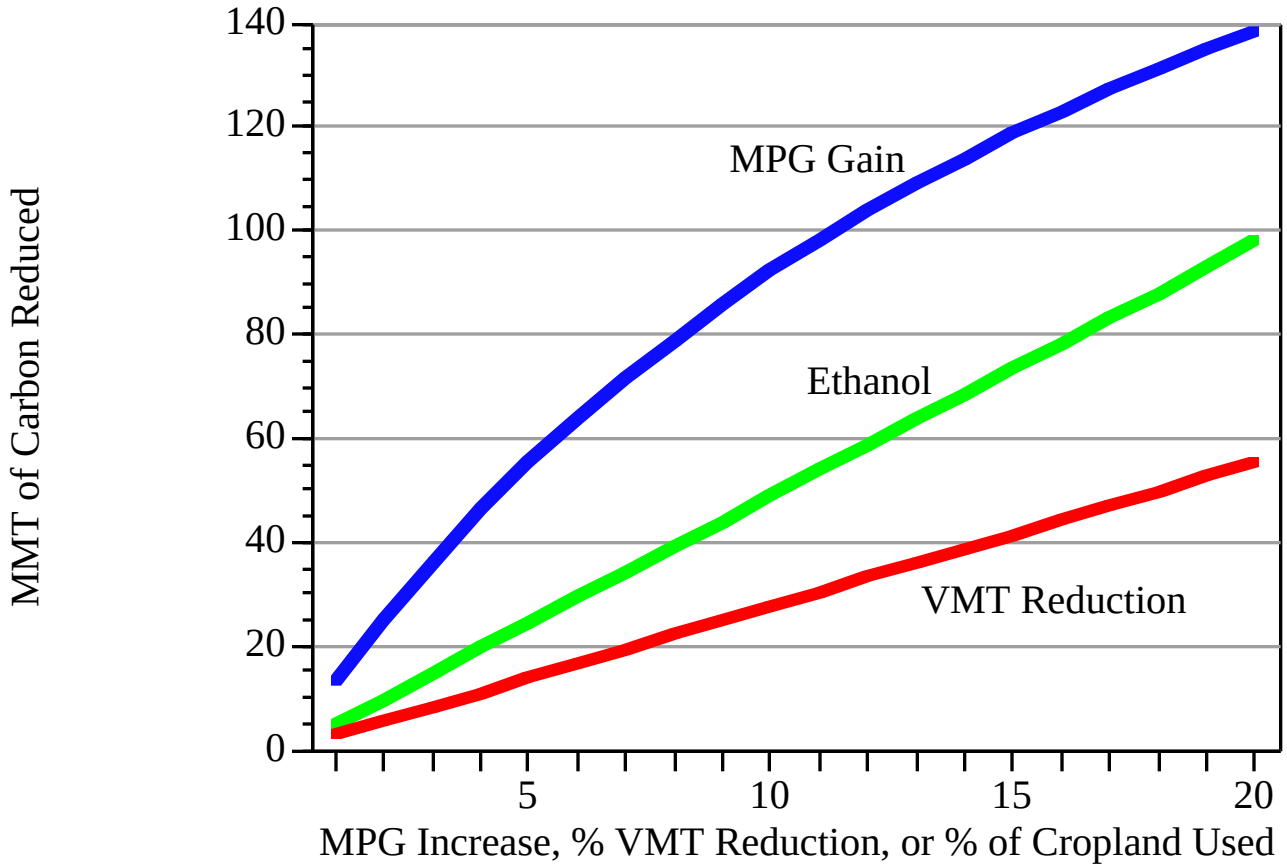
② Increase in use of zero carbon fuel (such as biomass ethanol)

★ One percent of cropland (about 4.4 million acres) would reduce carbon emissions by about 5 MMTC

③ Reduce the vehicle miles of travel (VMT)

★ A 1% reduction in light vehicle VMT will reduce carbon emissions by about 3 MMTC

Carbon Reduction Potential for Light Vehicles



New Car and Light Truck Fuel Economy Needed in the Final Year to Reach Carbon Targets by MPG Gains Only (Gain in LT fuel economy = 75% of car fuel economy gain)

Carbon Reduction	2010	2020
Trans. Share with Carbon Tax	Cars: 57.0 mpg	40.4 mpg
	LTs: 36.9 mpg	27.7 mpg
	(66 MMTC)	(68 MMTC)
Pro Rata Share	Cars: 99.8 mpg	60.0 mpg
	LTs: 60.7 mpg	38.6 mpg
	(108 MMTC)	(132 MMTC)

New Car and Light Truck Fuel Economy Needed in the Final Year to Reach Carbon Targets by MPG Gains Only (Gain in LT fuel economy = 50% of car fuel economy gain)

Carbon Reduction	2010	2020
Trans. Share with Carbon Tax	Cars: 63.0 mpg	42.9 mpg
	LTs: 33.8 mpg	26.3 mpg
	(66 MMTC)	(68 MMTC)
Pro Rata Share	Cars: 116.5 mpg	67.1 mpg
	LTs: 53.6 mpg	35.3 mpg
	(108 MMTC)	(132 MMTC)

New Car and Light Truck Fuel Economy Needed in 2020 to Reach Carbon Targets with Different LT to Car Improvement Ratios

LT to Car Improvement Ratio	
50%	Cars: 42.9 mpg
	LTs: 26.3 mpg
66%	Cars: 41.2 mpg
	LTs: 27.3 mpg
75%	Cars: 40.4 mpg
	LTs: 27.7 mpg

If we need a 50 MMTC reduction for light vehicles in 2010 from fuel economy gains, it makes a big difference how soon we begin improving fuel economy

New Vehicle Fuel Economy Needed in 2010 to Reach a 50 MMTC Reduction by 2010

Year Start	Cars	Light Trucks
2000	44.8	30.1
2001	45.8	30.7
2002	47.4	31.5
2003	49.8	32.9
2004	54.9	35.7
2005	74.5	46.6

Year 2000 Baseline MPG: Cars = 28.2 mpg; light trucks = 20.9 mpg

If we need a 50 MMTC reduction for light vehicles from fuel economy improvements, it makes a big difference if the reduction has to be done by 2010 or can wait until 2020

New Vehicle Fuel Economy Needed to Reach a 50 MMTC Reduction

MPG in the Final Year (start in 2002)	Cars	Light Trucks
2010	47.4	31.5
2020	36.6	25.6

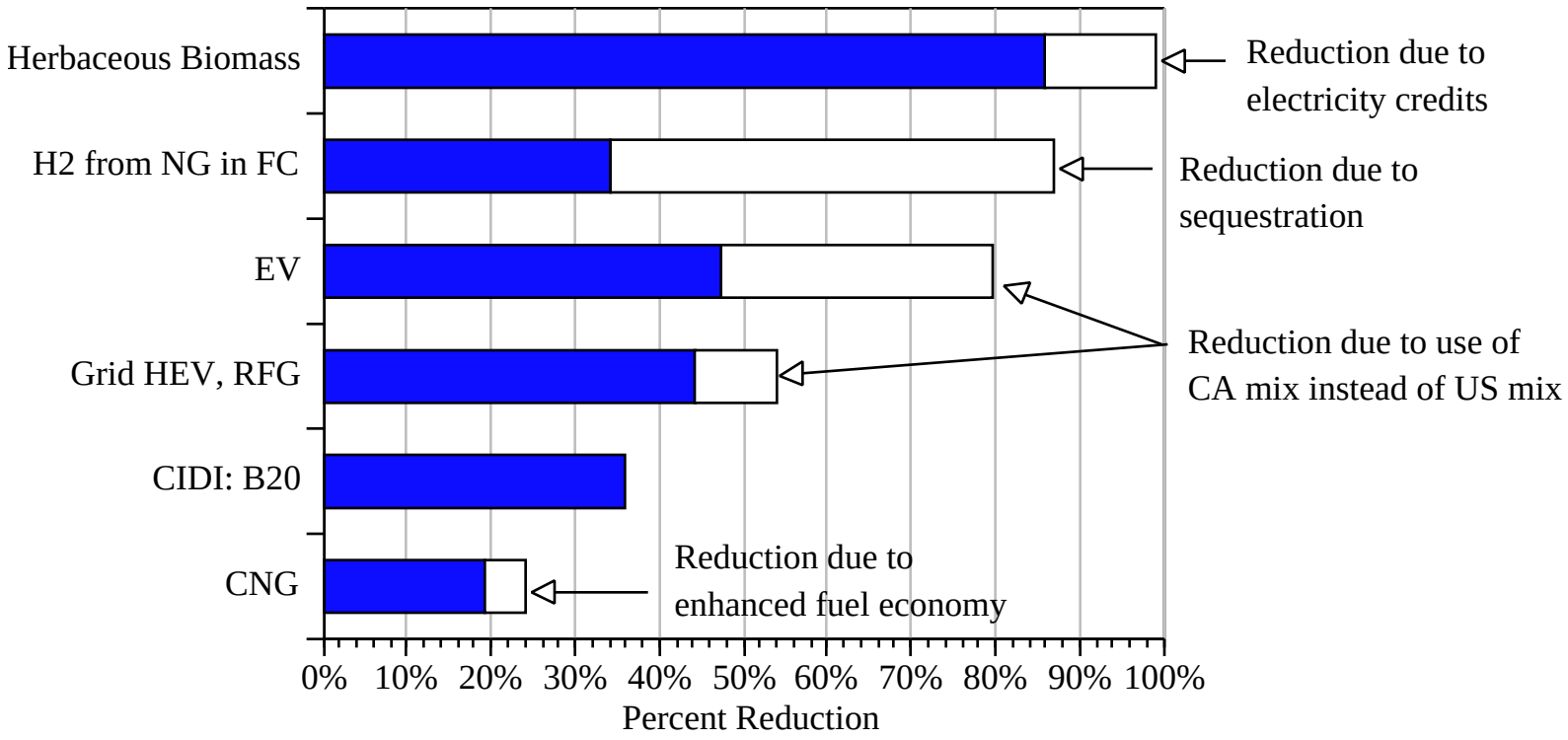
Year 2000 Baseline MPG: Cars = 28.2 mpg; light trucks = 20.9 mpg

Percent of 2X and 3X Vehicles Needed to Reach the Targets Using MPG Gains Only

Carbon Reduction	2010		2020	
Trans. Share with	*Cars*	*LTs*	*Cars*	*LTs*
Carbon Tax	65% 2X	77% 2X	40% 2X	45% 2X
	35% 3X		20% 3X	
Pro Rata Share			*Cars*	*LTs*
	Not Possible		53% 2X	83% 2X
			47% 3X	

Assumes LT = 50% of car fuel economy gain

GHG Reductions Relative to Gasoline (2010)



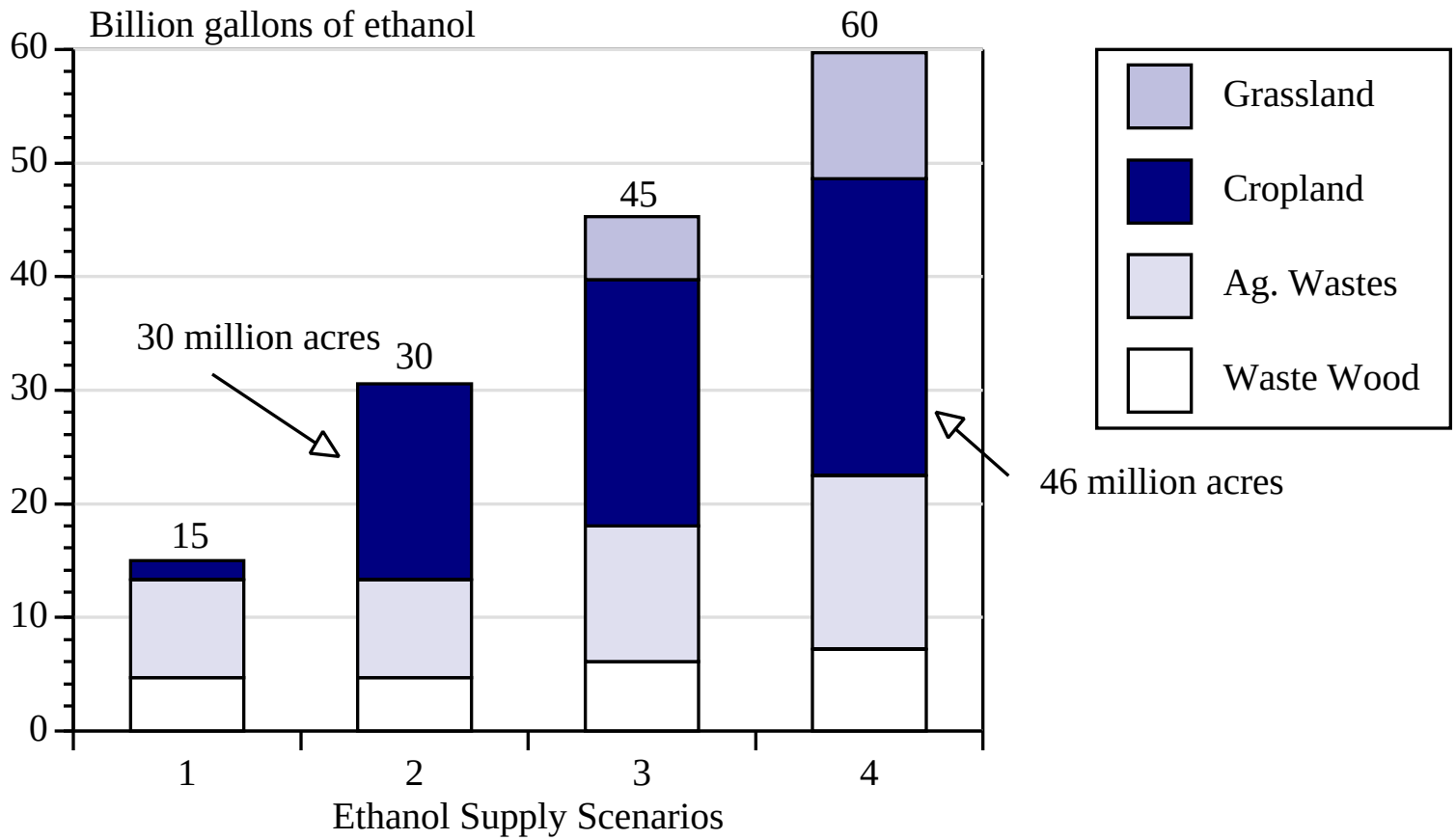
Source: Michael Wang, Argonne National Laboratory, GREET 1.4, September 1998.

Ethanol Supply Scenarios

	#1	#2	#3	#4
Ethanol (billion gallons)	15 (9.6)	30 (19.2)	45 (28.8)	60 (38.4)
Waste Wood (millions tons)	50	50	63	75
Ag. Wastes (million tons)	90	90	125	160
Cropland (million acres)	3	30	38	46
Grassland/ Rangeland (million acres)	0	0	30	59
Total Tonnage (million tons)	158	320	475	630
Carbon Reduction (MMTC)	21.4	42.8	64.2	85.6

Assumptions: Cropland yield = 6 tons per acre; grassland yield = 2 tons per acre; ethanol conversion efficiency = 95 gallons per ton. There is 460 million acres of cropland and 589 million acres of grassland in the US.

Ethanol Supply Scenarios

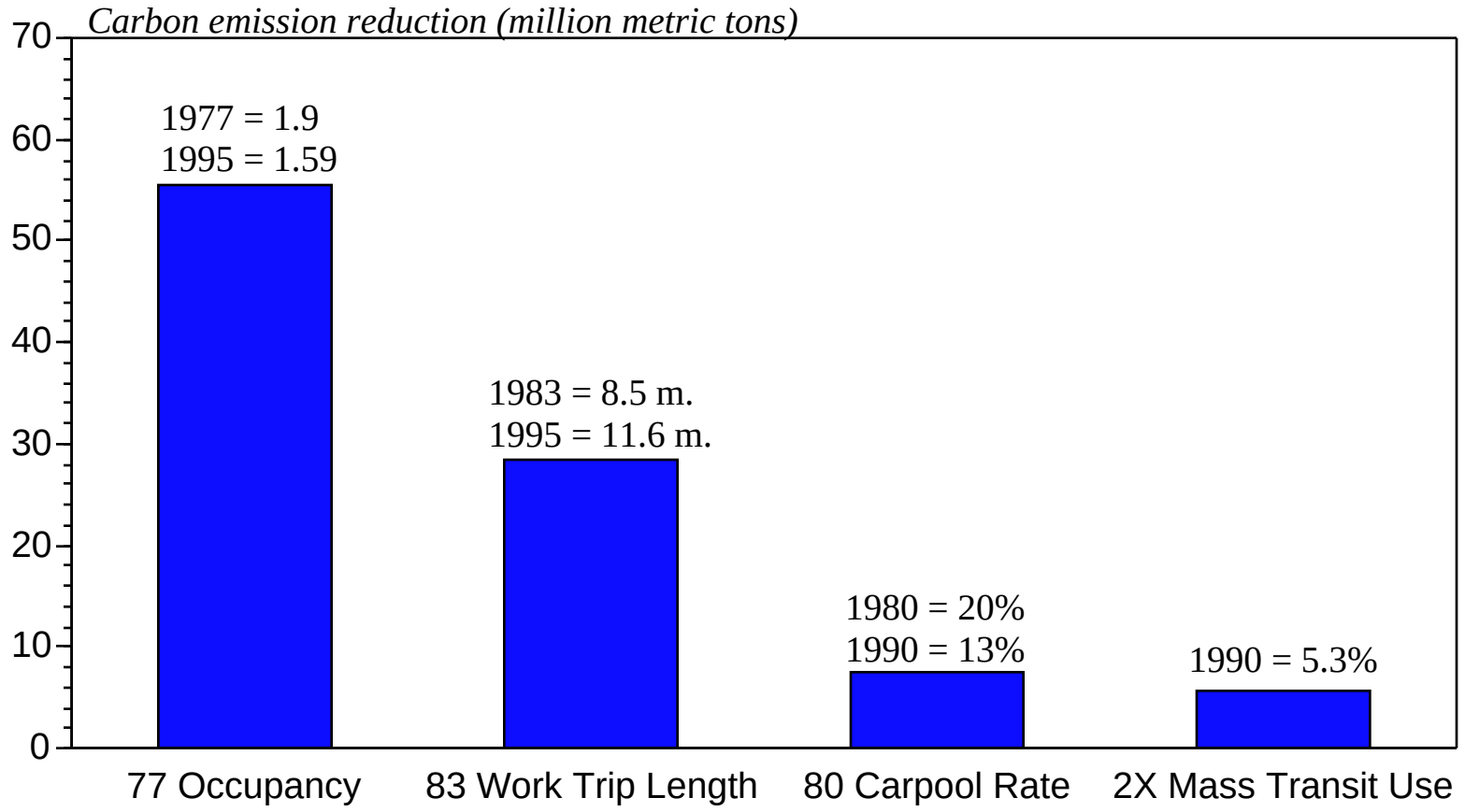


Other Fuels to Reach Carbon Reduction Targets for Light Vehicles in 2020

Carbon Reduction	
Trans. Share with Carbon Tax (68 MMTC)	56 million ethanol vehicles 64 million FCVs on hydrogen 70 million EVs 104 million grid connected HEVs 233 million CNG vehicles
Pro Rata Share (132 MMTC)	109 million ethanol vehicles 126 million FCVs on hydrogen 137 million EVs 202 million grid connected HEVs 454 million CNG vehicles (impossible)

Note: EIA projects that there will be 254 million light vehicles in 2020.

Comparison of Potential Carbon Reductions from VMT Reduction, 2010



Potential VMT Reduction from Trip Purpose Perspective

Purpose	Share of VMT	Reduction Measure	Purpose Reduction	Overall Reduction
Work	34.7%	10% telecommute 2 out of 5 days	4%	1.4%
Shopping	11.9%	5% teleshop	5%	0.6%
Vacation/Visit	14.4%	Reduce by 10%	10%	1.4%
Family Related	24.8%	Reduce by 5%	5%	1.2%
Other Social/ Rec.	14.2%	Reduce by 10%	10%	1.4%
Total				6%

Using a Plausible Mix of the Three Options to Reach the 2020 Target

	Trans. Share w/ Carbon Tax	Pro Rata
Carbon Reduction Needed	68 MMTC	132 MMTC
Fuel Economy 50% (LT=.75 Car MPG gain)	34 MMTC Car MPG = 33.5 LT MPG = 23.9	66 MMTC Car MPG = 40.1 LT MPG = 27.5
Biomass Fuels 35%	24 MMTC 112% of Scenario 1	46 MMTC 107% of Scenario 2
VMT Reduction 15%	10 MMTC 3.3% VMT Reduction	20 MMTC 6.7% VMT Reduction

The Carbon Reductions Implied by the Kyoto Protocol are Very Large in All Transportation Sectors (to Return to 1990 Levels in 2010)

Mode	Carbon Reduction
Light Vehicles	27%
Heavy Vehicles	42%
Aircraft	55%

Conclusions

Reducing Light Vehicle Carbon Emissions

- By 2010
  - 66 MMTC (19%) -- nearly impossible
  - 108 MMTC (31%) -- impossible
- By 2020
  - 68 MMTC (18%) -- plausible with mix of efficiency, low carbon fuels, and VMT reduction
  - 132 MMTC (35%) -- possible if a major commitment was made to do so

Reducing Heavy Truck and Aircraft Carbon Emissions

- Going to be very hard to do. Need to rely on efficiency improvements.